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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P26981PC02/JJO	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/NL2004/000752	International filing date *(day/month/year)* 26.10.2004	Priority date *(day/month/year)* 27.10.2003
International Patent Classification (IPC) or national classification and IPC A61L9/20, A61L9/16, F24F3/16, A61L9/22		
Applicant SILDERHUIS, Hermannus G.M.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 9 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 32 sheets, as follows:
      - ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - ☒ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☒	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

Date of submission of the demand 18.05.2005	Date of completion of this report 06.02.2006
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Marti, P Telephone No. +49 89 2399-7858

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/NL2004/000752

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-22	received on 14.12.2005 with letter of 08.12.2005

Claims, Numbers

1-39	received on 14.12.2005 with letter of 08.12.2005

Drawings, Sheets

1/4-4/4	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. IV Lack of unity of invention

1. ☐ In response to the invitation to restrict or pay additional fees, the applicant has:
   - ☐ restricted the claims.
   - ☐ paid additional fees.
   - ☐ paid additional fees under protest.
   - ☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, this report has been established in respect of the following parts of the international application:

   ☒ all parts.

   ☐ the parts relating to claims Nos. .

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	10,12,14,17-22,24-26,37,38
	No:	Claims	1-9,11,13,15-16,23,27-36,39
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-39
Industrial applicability (IA)	Yes:	Claims	1-39
	No:	Claims	

2. Citations and explanations (Rule 70.7):

   see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (SEPARATE SHEET)

International application No.

PCT/NL2004/000752

Re Item I

Basis of the report

1. The amendments filed with letter of 08.122005 introduces subject-matter which extends beyond the content of the application as originally filed (Art. 34(2)(b) PCT). In particular, there is no basis in the application for the following expression in claim 1: "*the controlling of any of (a) - (h) taking place in a way such that the micro-organisms receive at least a certain minimum doses of UV radiation to ensure that they get killed*".

   According to the applicant, the last paragraph in claim 1 has a basis on page 1, lines 29 to page 2 line 5, addressing this paragraph in the original context merely a problem inherent to the prior art to be solved by the present invention, and not a discussion of the prior art.

   However, this passage of the description states only that the microorganisms need to receive at least a certain minimum dose of UV light to ensure that they get killed. There is no basis in the application as originally filed for a ensuring that the microorganisms receive a certain minimum doses **by controlling** the air flow rate (feature (a) in claim 1), the power consumption of the first UV light for protecting it against overheating (c), the power output of the first UV radiation source from undercooling of underheating (d), the temperature of the first UV radiation source for protecting it against overheating (e), the temperature in the UV chamber (g).

   Moreover, lack of clarity within the meaning of Art. 6 PCT arises, since it is not clear from the application as to how, e.g., the power consumption of the first UV radiation source (feature (c)) can be controlled for protecting said first radiation source against overheating and at the same time it can be controlled that the microorganism receive at least a certain minimum dose (see also Item VIII below).

   Consequently, the above mentioned expression in claim 1 will not be considered for the purpose of substantive examination.

Re Item IV

Lack of unity of invention

1. Claim defines an air treatment device characterised by means for controlling at least one of eight different parameters ((a) to (h)). Since an air treatment device comprising all the features of the preamble and comprising control means (=power switches) is already known from D11 (at least, see Item V below), the eight different alternatives defined in claim 1 are not so linked as to form a single general inventive concept. Therefore, the present set of claims lacks unity within the meaning of Rule 13 PCT.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

D1: WO 2004/011041 (corresponding to US 2004/047776 A1)
D4: EP-A-1 239 232
D5: EP-A-0 550 366
D6: DE 102 09 994 A
D8: DE 196 52 688 A
D9: WO 03/078571 A
D11: US-A-6 053 968

2. The priority document has been checked and the claimed priority is valid. However, the attention of the applicant is drawn to the possible relevance of the disclosure of D1 for the subject-matter of the claims before any national or regional, further examination procedure, if any.

3.1 Document D4 discloses an air treatment device comprising a housing (10, 11), a fan (26), an UV treatment chamber (36) comprising an UV lamp (40) and a HEPA filter (17, see col 3. line 56) upstream to the UV treatment chamber. Further, means (= sensors) for controlling the fan, the UV lamps, the temperature are also known from

D4 (see paragr. 31 and claim 13).

Hence, the disclosure of D4 is novelty destroying for the subject-matter of claim 1 (Art. 33.2 PCT).

The same applies to claim 32.

3.2 Document D11 can be considered as the closest prior art document for the subject-matter of claim 1. It discloses an air treatment device (= portable room air filter) comprising a housing (see figures), a fan (28), an UV treatment chamber (20) comprising an UV lamp (24), a HEPA filter (26) upstream of the UV treatment chamber, and a dust filter (see col. 2, lines 30-31) upstream of the HEPA filter. The device defined in present claim 1 differs from the devices of D11 in that means are used for controlling at least one of the air flow rate, the humidity of the air in the chamber, the power consumption of the UV lamp, the power output of the UV lamp, the temperature of the air, the temperature of the UV source, the temperature in the UV chamber or the number of microorganism. The objective technical problem to be solved by claim 1 with respect to D11 would be therefore the provision of a device which can be controlled. However, this is a trivial problem in view of the available prior art documents.

D5 discloses also an air treatment device comprising a dust filter (18), a fan (20), a HEPA filter (23) and a UV light source (25) placed upstream of the HEPA filter. D5 teaches that the device can be controlled using means for controlling the air flow (see col 5, lines 5-9).

D6 discloses an air treatment device comprising a housing (see figure), a fan (5), an UV treatment chamber (7), and an active carbon filter. Further, a temperature sensor (8) is used for controlling the temperature of the air.

D8 discloses an air treatment device comprising a housing (1), a fan (18), an UV treatment chamber (22), and means for controlling the UV lamps and the air flow (see claim 26).

The air treatment device disclosed in D9 comprises a housing (see figures), a fan (42), an UV treatment chamber (12). The device further comprises sensors for controlling the device such as microorganism sensors (61, 62, 63, see page 8, lines 14-17), and sensors for the temperature and humidity (see page 8).

A skilled person being aware of D11 would obviously consider the teaching of D5, D6, D8 or D9 in order to arrive at the proposed solution.

Hence, the subject-matter of claim 1 does not involve an inventive step in the light of D11 in combination with each of D5, D6, D8 or D9 (Art. 33.3 PCT).

The same applies to claims 31 and 32.

4. Dependent claims 2-30 and 33-39 contain features which either are disclosed in the cited documents or fall within the customary practice followed by persons skilled in the art and do not involve an inventive step as no particular or unexpected effect is apparent.

Re Item VIII

Certain observations on the international application

1. It is not clear as to how the parameters of "a" to "g" in claim 1 can be controlled without measuring the amount of microorganisms (Art. 6 PCT). An essential feature is probably missing (i.e. a microorganism sensor).

2. The option "c" in claim 1 the device comprises means for controlling the power consumption of the first UV radiation source for **protecting said first UV radiation source against overheating or undercooling**. It is not clear as to how the power consumption of the first UV radiation source can be used for protecting the radiation source and, at the same time, for controlling the dose of UV radiation received by the microorganisms (Art. 6 PCT).

The same applies to options "d" and "e".

International patent application no. PCT/NL2004/000752
Enclosure with letter of December 8, 2005

Sch/svk/Silderhuis-1pct

NEW DESCRIPTION (AMENDMENTS MARKED)

AIR TREATMENT METHOD AND DEVICE

The present invention relates to an air treatment method and an air treatment device for killing micro-organisms present in air.

In bounded spaces, such as rooms, in houses, buildings or other human or animal living environments, numerous pollutants such as dust and micro-organisms like viruses, bacteria and fungi are present.

These pollutants endanger the health of the human beings or animals living in these bounded spaces.

An air treatment device for improving the air quality in bounded spaces is known, e.g. from US-A-5 185 015. This prior art treatment device comprises three filters. A first filter filters particles larger than a predetermined size from the air, a second filter filters particles of selected chemical species and a third filter removes the reproducing capacity of airborne bacteria to reproduce by irradiating ultraviolet radiation.

The known air treatment device however has a limited air cleaning capacity and a limited airflow capacity. Having a small airflow capacity the air treatment device is only effective if it is used in a small room that is kept closed over a long period of time. After the room is exposed to normal, polluted air, for example when a door or window is opened, the room is contaminated again and it takes a long period of time again to decontaminate the air in the room, which has to

be closed again for this purpose.

Moreover, the known air treatment device is only suited for removing relatively large micro-organisms from the air. The known air treatment device uses conventional filters for removing particles having diam larger than a predetermined filter pore diameter. Micro-organisms having smaller diam may pass the filters and thus remain in the air.

Increasing the airflow capacity of the air treatment device is only possible if all bacteria and other micro-organisms such as viruses are completely destroyed. If ultraviolet radiation is used in doses that will not kill micro-organisms, micro-organisms get mutated, since micro-organisms only get killed after receiving certain doses of ultraviolet ~~light~~radiation. Since mutated micro-organisms may form even a greater threat to humans and animals than non-mutated micro-organisms, the micro-organisms must receive at least that certain minimum doses of ultraviolet radiation ~~ultraviolet light~~ to ensure that they get killed. A high capacity air treatment device therefore needs to be designed and configured to ensure that virtually all micro-organisms get killed and no mutated micro-organisms leave the air treatment device.

US-A-6 053 968 discloses an air treatment device comprising:

- a housing comprising an air inlet and an air outlet;

- a fan for stimulating an airflow through the housing from the air inlet to the air outlet;

- a UV treatment chamber downstream relative to said air inlet, the UV treatment chamber comprising at least one first UV radiation source for exposing said airflow to UV radiation for killing micro-organisms present in said airflow; and

- a HEPA filter ~~t least one filter~~ positioned upstream relative to the UV treatment chamber for removing particles and micro-organisms having sizes

larger than a predetermined filter pore diameter from said airflow before exposing said airflow to said UV radiation.

According to the invention ~~this prior~~ the device is ~~Device~~ ~~is~~ characterized by means for controlling at least one of:

(a) the airflow rate;

~~(b) the hydration level;~~

(b~~c~~) the humidity in the UV treatment chamber

(c~~d~~) the power consumption of the first UV radiation source for protecting said first UV radiation source against overheating or undercooling;

(~~e~~d) the power output of the first UV radiation source for protecting said first UV radiation source from undercooling or overheating;

(e~~f~~) the temperature of the first UV radiation source for protecting said first UV radiation source against overheating or undercooling;

(f~~g~~) the temperature of the air leaving the UV treatment chamber, this temperature being a measure for the amount of UV radiation being radiated on the micro-organisms;

(g~~h~~) the temperature in the UV treatment chamber, such that said temperature may be kept at a predetermined temperature level; and

(h~~i~~) the air treatment device in response to the number of micro-organisms determined by a a micro-organism sensor;

the controlling of any of (a) - (h) taking place in a way such that ~~t~~the micro-organisms receive at least a certain minimum dosis of UV radiation to ensure that they get killed.

The air treatment device according to the present invention is configured to expose micro-organisms present in air to UV radiation in order to kill said

micro-organisms after removing part of the micro-organisms using one or more conventional filters. Thus, the air treatment device is suited for removing and/or killing micro-organisms of any size instead of only removing micro-organisms having a size larger than a predetermined filter pore diameter.

Large micro-organisms need a large dose of UV radiation to get killed, while small micro-organisms only need a relatively small dose. Therefore, the air treatment device comprises at least one filter upstream relative to the UV treatment chamber for removing particles and micro-organisms having sizes larger than a predetermined filter pore diameter from said airflow before exposing said airflow to said UV radiation. Thus, only small micro-organisms reach the UV treatment chamber. Said small micro-organisms may be killed by a small dose of UV radiation, thus requiring less UV radiation for killing all micro-organisms.

In the UV treatment chamber the air in the airflow, and in particular each micro-organism in the air, is irradiated by UV radiation. Each micro-organisms must receive the above-mentioned minimum dose of UV radiation in order to be killed. This means that each micro-organism must receive a certain power of UV radiation during a certain period of time. Thereto the UV treatment chamber is configured such that the air remains in the UV treatment chamber during a predetermined minimum period of time, the "time of residence" and the at least one first UV radiation source emits a predetermined UV power. Reference is made to US-A-6 053 968, paragraphs [0075] - [0078], from which this aspect is clear per se.

A suitable first UV radiation source emits UV radiation with a wavelength of about 253 - 257 nm, in particular 253.7 nm.

In order to decontaminate large amounts of air per unit time, all elements in the air treatment device, in particular the filters, may be complementary selected and positioned relative to each other. In an embodiment, the

air treatment device according to the present invention may comprise a dust filter and a HEPA filter. The dust filter removes all large particles, such as dust particles, from the air flowing through the housing.

Preferably the dust filter is a removable and/or washable filter to be able to easily clean the filter and to have a long use life of the dust filter.

Smaller particles that are not removed by the dust filter may be removed by the HEPA (high efficiency particle arrestance) filter. A HEPA filter is a filter type known in the art and designed to remove small particles. A range of HEPA filters is known, the filters in said range differing in the percentage of particles larger than 0.3 μm that is removed by said filter.

In an embodiment according to the present invention, a HEPA filter constructed of glass fiber and removing about 99.97% of the particles larger than 0.3 μm is preferably used. Such a HEPA filter is known as a H13 HEPA filter and removes about all dust particles and also removes large bacteria from the air.

Instead of a dust filter and/or a HEPA filter, any other filter may be employed for removing pollutants having a size larger than a predetermined size. For example, a carbon filter may be employed.

As mentioned above, a filter, e.g. a HEPA filter, may remove large bacteria from the air. These large bacteria thus remain in the filter. Since the filter functions as a hothouse, a large bacteria growth is to be expected, which may result in mutated bacteria. Further, the filter wears off in the course of time due to the air and particles flowing through the filter. Therefore, in the course of time, larger particles and in particular larger bacteria, even the ones earlier caught in the filter, may flow through the HEPA filter. In order to avoid these effects, a second UV radiation source may be provided radiating UV radiation on the filter to kill the bacteria that remain on the filter. A suitable second UV radiation source emits UV radiation with a wavelength of

about 253 - 257 nm, in particular 253.7 nm.

Thus, by killing the bacteria caught by the filter, no bacteria, which may have grown in population and/or may have mutated during their stay on the filter, may flow through the filter in the course of time. Further, the filter may be safely replaced by a new filter as soon as the filter has worn off without having to take the old filter out with a large amount of possibly mutated bacteria thereon.

In order to kill bacteria, the bacteria need to receive a certain minimum dose of UV radiation. The received dose of UV radiation is equal to the UV power times the time during which the bacteria are exposed to said UV power. Thus, using a high-power UV radiation source, the bacteria need to be exposed only during a short period of time to get killed. However, the bacteria caught on the filter cannot move. Therefore, theUV radiation source may be a low-power UV radiation source, since the bacteria may be exposed during a long time, in the end resulting in receiving the required minimum dose to get killed.

To ensure that all micro-organisms receive UV radiation in the UV treatment chamber and no micro-organisms may pass the at least one first UV radiation source in the shadow of other micro-organisms, the fan may be positioned in the air treatment device such that the airflow in the UV treatment chamber is turbulent. This means that the fan may be positioned upstream relative to the UV treatment chamber, since the airflow stimulated by a fan is always turbulent at the pressure side of the fan. At the side from where the air is drawn, the airflow may be laminar for relatively low airflow rates. However, it is noted that for high airflow rates the flow is turbulent at the drawing side and thus in the device according to the present invention the fan may also be positioned relative to the UV treatment chamber when only using high airflow rates.

An inner wall of the UV treatment chamber may be

provided with a UV radiation reflecting layer. UV radiation emitted by the first UV radiation source may thus be more efficiently used for irradiating micro-organisms. UV radiation that did not interfere with a micro-organism the first time it passed the UV treatment chamber may interfere with another micro-organism after it has been reflected by the reflecting layer on the inner wall of the UV treatment chamber.

It has been found that the metal lattice of aluminium is specifically suitable for constructing the reflective layer. The wavelengths of the UV radiation that is used are at least partially reflected by aluminium.

To fill the UV treatment chamber with UV radiation coming from all possible directions and thus increasing the chance of interference with passing micro-organisms, it is advantageous to scatter the UV radiation when it is reflected. Therefore, it is advantageous that the reflective layer has a rough surface such that reflected UV radiation is scattered. In a specific embodiment, the reflective layer is formed by sputtered aluminium, since such a sputtered layer of aluminium reflects and scatters the incident UV radiation.

In an advantageous embodiment, the air treatment device further comprises a cooling unit upstream relative to the UV treatment chamber for cooling and/or dehydrating the airflow.

The cooling unit, which may receive air only containing small particles, which are mainly bacteria, viruses, fungi and other micro-organisms, has two functions. The cooling unit cools the air, and it dehydrates the air. The air is cooled to provide air with an optimal temperature to the UV treatment chamber. Which temperature is optimal will be described hereinafter.

The air is dehydrated to prevent that water molecules become attached to the micro-organisms, since attached water molecules form a shield against UV radiation around the micro-organisms. It has been found

that it may take up to a four times higher dose of UV radiation to kill a micro-organisms having a water molecule shield around it. Dehydrating the air results in less shielding and thus results in requiring less UV radiation in the UV treatment chamber to kill bacteria.

Dehydration is established by cooling the air. Cold air can contain less water molecules than hot air. Cooling the air results in condensation of a percentage of the water present in the air. The condensed water may be stored in a tank, which is to be emptied by a person when it is full. Also, the condensed water may be directly drained. In a specific embodiment, the condensed water may be vaporized in the airflow again after the micro-organisms have been killed to prevent that unnaturally dry air is output by the air treatment device.

In an advantageous embodiment the air treatment device comprises an ionizer, downstream relative to said at least one filter if present, and downstream to said cooling unit if present, for providing an electron stream substantially perpendicular to the direction of airflow.

The ionizer generates an electrical field. A function of the ionizer results from an electron stream inevitably running from one pole of the ionizer to the other. Micro-organisms may get hit by one or more electrons and get killed or weakened. If the ionizer is positioned downstream to the UV treatment chamber, any micro-organisms, which inadvertently have been able to survive the UV treatment chamber, possibly having been mutated, get irrigated with the electrons in said stream and get killed. To provide a large electron stream, the poles of the ionizer may be designed with a large surface. For example, the poles may be constructed as a brush of electrically conducting wires.

The ionizer may further function to re-hydrate the passing air. As an electrical field is generated between two electrical poles of the ionizer, water molecules get polarized, i.e. they orientate themselves all in a same

direction. This is an effect that is well known to a person skilled in the art. Due to the polarization, the water molecules become easily attached to molecules in the air, hydrating the air to a natural ~~hydration level~~humidity.

In an embodiment of the device according to the present invention, the air treatment device further comprises a second carbon filter downstream relative to the filter. A carbon filter is known in the art for capturing gases, and thus reducing smells present in the airflow.

In a still further embodiment, the cooling unit and the carbon filter may be combined to one unit. The combined filter may capture liquids, in particular water, and gases by polarization and cool the air. By controlling an electrical potential of electrodes comprised in the combined unit the humidity and the temperature of the air passing the combined filter may be controlled.

To control the humidity, and thus the amount of water adhering to micro-organisms, the air treatment device may comprise a humidity sensor downstream relative to the cooling unit, which sensor determines the humidity of the air and outputs corresponding humidity data. The humidity data are received by a processing device from the humidity sensor, which processing device controls the cooling unit to provide a predetermined humidity in the UV treatment chamber. Thus, the humidity of the air in the UV treatment chamber may be kept at the predetermined humidity level irrespective of the humidity of the air entering the air treatment device at the air inlet. Preferably, the humidity sensor is disposed in the UV treatment chamber to obtain the humidity level in the UV treatment chamber directly.

Similarly, to control the temperature, the air treatment device may comprise a temperature sensor downstream relative to the cooling unit, which sensor determines the temperature of the air and outputs

corresponding temperature data. The temperature data are received by a processing device from the temperature sensor, which processing device controls the cooling unit to provide a predetermined temperature in the UV treatment chamber of the UV treatment chamber. Thus, the temperature of the air in the UV treatment chamber may be kept at the predetermined temperature level as long as the temperature of the air entering the air treatment device at the air inlet is higher than the predetermined temperature.

In an embodiment of the air treatment device, the first temperature sensor is disposed immediately downstream relative to the UV treatment chamber. The temperature of the air leaving the UV treatment chamber is a measure for the amount of UV radiation being radiated on the micro-organisms. Thus, by determining and controlling the temperature of the outgoing air, it may be ensured that the micro-organisms have received enough UV radiation to be killed.

In an embodiment, the at least one first UV radiation source may be provided with a second temperature sensor and a processing device may be provided receiving temperature data from that second temperature sensor. The processing device controls a power output of the first UV radiation source based on the received temperature data to protect the first UV radiation source from undercooling or overheating. Since the temperature of the air flowing into the UV treatment chamber may vary and since the airflow rate into the UV treatment chamber may vary, the first UV radiation source may have a problem of generating or dissipating heat generated during operation, which may result in overheating or undercooling. Overheating or undercooling is prevented by determining the temperature of the first UV radiation source and adjusting the output power of the first UV radiation source based on said determined temperature.

Advantageously, the first and/or second UV radiation

source may be disposed in a cover, that is transmissive for the emitted UV radiation. The cover protects humans against harmful chemical compounds present in the UV radiation source, in case the UV radiation source should break. Further, such a cover may protect in particular the UV radiation source against abrupt cooling down due to cold air entering the air treatment device. This is specifically advantageous, because cold air entering the UV treatment chamber adversely affects the air treating capacity of the UV treatment chamber. A suitable cover is made of PTFE (= Teflon®), since PTFE is transmissive for the used UV radiation and does not degrade in course of time due to the UV radiation.

It is noted that a cover transmissive for the emitted light of a light source may as well be advantageously employed in combination with any other light source comprising harmful chemical compounds, for example tube lights (TL) and gas discharge lamps, in order to contain said chemical compounds in case of breakage of the light source. Also, in combination with lamps constructed of glass, a transmissive cover may be employed to contain shattered glass splinters in case of breakage.

The air inlet and the air outlet of the housing of the air treatment device may be constructed such that no UV radiation may escape from the housing, since the used UV radiation is harmful to humans. A person skilled in the art readily understands how such a construction may be designed. For example, a maze-like construction may be used. Further, a UV radiation absorbing layer may be provided on a wall of the housing, or part thereof.

The air treatment device according to the present invention can be used in medical, residential, commercial, industrial and military and animal growing applications, either as a stand-alone unit, or as part of a further air conditioning system.

In another aspect, the present invention provides an air treatment method comprising the steps of

- generating an airflow;
- filtering particles and micro-organisms having sizes larger than a predetermined filter or pore diameter from said airflow before exposing said airflow to said UV radiation;
- exposing said airflow in a UV treatment chamber to UV radiation emitted by a least one first UV radiation source for killing micro-organisms present in said airflow; and
- controlling at least one of:

(a) the airflow rate;

~~(b) the hydration level;~~

(b~~c~~) the humidity in the UV treatment chamber

(c~~d~~) the power consumption of the first UV radiation source for protecting said first UV radiation source against overheating or undercooling;

(d~~e~~) the power output of the first UV radiation source for protecting said second UV radiation source from undercooling or overheating;

(e~~f~~) the temperature of the first UV radiation source for protecting said first UV radiation source against overheating or undercooling;

(f~~g~~) the temperature of the air leaving the UV treatment chamber, this temperature being a measure for the amount of UV radiation being radiated on the micro-organisms;

(g~~h~~) the temperature in the UV treatment chamber chamber, such that said temperature may be kept at a predetermined temperature level; and

(h~~i~~) the air treatment method in response to the number of micro-organisms determined by a micro-organism sensor;

the controlling of any of (a) - (h) taking place in a way such that

the micro-organisms receive at least a certain minimum dosis of UV radiation to ensure that they get killed.

Aspects, advantages and features of the device according to the invention are explained in more detail by reference to the accompanying drawings illustrating exemplary embodiments, in which:

Fig. 1 schematically shows the structure of an air treatment device according to the present invention;

Fig. 2a shows a perspective view of an air treatment device according to an embodiment of the present invention;

Fig. 2b shows a sectional view of the embodiment illustrated in Fig. 2a;

Figs. 2c - 2e show parts of the sectional view of Fig. 2b on a larger scale;

Fig. 3 shows a graph of a pollutant removal factor as a function of a pollutant size; and

Fig. 4 shows a graph of a UV radiation source efficiency as a function of the cooling air flow rate.

In the different Figures, like reference numerals indicate like components or components having the same function.

Fig. 1 schematically illustrates the arrangement of various components in an air treatment device, which is generally indicated with reference numeral 1.

The air treatment device 1 comprises an elongated tube-like housing 2, having a cross-section which is generally circular or oval shaped, or has any other suitable cross-sectional shape, such as a rectangular or polygonal shape. The shape or the area of the cross-section of the housing 2 may vary along its length. In a preferred embodiment, the cross-section is circular, is constant along the length of the housing 2, and has a diameter of about 0.2 - 0.3 m.

The housing has an air inlet 4 at a first end thereof, and an air outlet 6 at a second end thereof. Air generally is intended to flow through the housing 2 from the air inlet 4 to the air outlet 6. In one embodiment, a

longitudinal axis of the housing 2 may be directed upright or generally vertically, with the air inlet 4 located at the lower end of the housing 2, and the air outlet 6 located at the upper end of the housing 2. However, in principle any orientation of the air treatment device may be selected.

From the air inlet 4 to the air outlet 6, air flowing through the housing 2 follows a path through or along various components, such as a dust filter 10, a HEPA filter 12, a carbon filter 14, a fan 16, an ionizer 18, and a UV treatment chamber 20 containing at least one first UV radiation source 22, in order to ensure the capture of particles and/or the termination of substantially all viruses, bacteria and other harmful micro-organisms in the air treatment device. Although the dust filter 10, the HEPA filter 12, and the carbon filter 14 are shown in Fig. 1 to be free from the housing 2, in a practical embodiment they extend to an inner wall (indicated with dashed lines) of the housing 2 to ensure that all air flowing through the enclosure 2 passes through each of these filters.

The dust filter 10 is situated downstream relative to the air inlet 4 to capture dust particles in the air having relatively large dimensions. The dust filter 10, being the first filter in the air treatment device 1, is also referred to as a prefilter. Preferably, the dust filter 10 is exchangeable and/or washable.

The HEPA (High Efficiency Particulate Air) filter 12, preferably manufactured from microfiber glass, is situated downstream relative to the dust filter 10, to capture small particles with sizes of about 0.1 to 0.3 μm and higher. The HEPA filter 12 may remove as much as 99.97% of airborne pollutants, and will further capture at least part of the total amount of viruses, bacteria, and fungi present in the air. A relatively small UV(C) (Ultra Violet rays type C) radiation source 11 situated in the vicinity of the HEPA filter 12 will kill the viruses, bacteria, and fungi captured in the HEPA filter

12 in the course of time. Preferably, the HEPA filter 12 is exchangeable. Also preferably, the UV(C) radiation source 11 emits radiation at about 253.7 nm or any other suitable wavelength, and at an operating temperature of 40°C or any other suitable operating temperature. The UV(C) radiation source 11 is preferably placed at the side of the HEPA filter 12 facing the air inlet 4 of the housing 2.

The carbon filter 14 is situated downstream relative to the HEPA filter 12, and comprises electrodes (not shown) with an adjustable potential, to capture liquids (in particular water) and gases by polarization. Thus, the humidity of the air passing the carbon filter 14 may be controlled by controlling the potential of the electrodes of the carbon filter 14. By controlling the humidity of the air, the amount of water adhering to viruses and bacteria may be controlled with a view to controlling the effectiveness of the air treatment in the UV treatment chamber 20. A humidity sensor 13 located downstream relative to the carbon filter, preferably located in the UV treatment chamber 20, provides humidity data which are processed in a processing device 15 coupled to the humidity sensor 13. The processing device 15 is coupled to the electrodes of the carbon filter 14, and controls the potential of the electrodes in a predetermined manner such as to achieve a predetermined humidity of about 40-50% in the UV treatment chamber 20, irrespective of the humidity of the air entering the air inlet 4 of the air treatment device 1. Gases are also captured in the carbon filter 14, thus reducing any smells present in the air flowing through the air treatment device 1.

The fan 16 is situated downstream relative to the carbon filter 14 to generate high air flows in the air treatment device 1. A temperature sensor 17 is located in the UV treatment chamber 20, and coupled to a processing device (which may or may not be the same as the processing device 15 described above). The processing

device is coupled to a motor of the fan 16, and controls the motor speed, and thus the flow rate of the air in the air treatment device 1, for achieving a predetermined temperature in the UV treatment chamber 20. This temperature depends on the amount of cooling of the at least one UV(C) radiation source 22 in the UV treatment chamber 20 by the air flowing by the at least one UV(C) radiation source 22.

In a practical embodiment, typically the air should flow along the at least one UV(C) radiation source 22 with a speed of about 1.5 m/s to reach a steady state temperature in the UV treatment chamber 20 of about 40°C. Such a temperature will effect an optimum sterilization of the air in the UV treatment chamber, which can be achieved irrespective of the air temperature of the air entering the air treatment device at the air inlet 4, by controlling the motor speed of the fan 16. Depending on the configuration of the air treatment device 1, airflow delivery rates of 76 m^3/h up to 380 m^3/h (hyper dynamic flows) are possible, which would lead to an average room with a floor area of 4 x 8 m^2 having its entire volume treated in the air treatment device 1 several times per hour. It is noted that a minimum airflow rate of approximately 1.5 m/s is needed to ensure that an airflow is generated in the whole room such that substantially all air present in the room may be treated.

By placing the fan 16 downstream relative to the dust filter 10, the HEPA filter 12, and the carbon filter 14, the fan 16 can be kept clean. However, if the fan 16 would be positioned upstream to one or more of said filters and it would get polluted, any filter downstream to the fan 16 will remove any particle airborne from said polluted fan 16.

The ionizer 18 is located downstream relative to the fan 16, and returns the ionization of the air to natural, human-friendly values.

The UV treatment chamber 20 contains the at least one UV(C) radiation source 22, preferably emitting UV(C)

radiation at about 253.7 nm or any other suitable wavelength, and preferably being driven at 100% power output when operating at 40°C. The at least one UV(C) radiation source 22 has an integrated temperature sensor 24 protecting the at least one UV(C) radiation source 22 from undercooling or overheating by adapting the power output thereof accordingly. The walls of the UV treatment chamber 20 are adapted to provide a maximum reflection of UV(C) radiation. For this purpose, preferably aluminium has been sputtered on the walls of the UV treatment chamber 20. Accordingly, direct and up to seven times reflected UV(C) radiation may increase the sterilizing efficiency of the UV treatment chamber 20 by 300%. The at least one UV(C) radiation source 22 is constructed such, that no ozone is created by its operation.

The air outlet 6 is constructed such that no UV(C) radiation may escape from the air treatment device 1. A special radiation absorbing paint is applied to the walls of the air outlet 6, and a maze-like structure of the air outlet 6 prevents any radiation from leaving the device.

The signals generated by the temperature sensors 17 and 24, and the humidity sensor 13 are evaluated in respective processing devices coupled thereto, and the processing devices are adapted to turn off the air treatment device 1 if a potentially abnormal situation is detected, or if a situation arises in which a condition for replacement of a component of the air treatment device 1 is met. Examples of such situations are: stopping of the fan 16, overheating or undercooling of components, in particular the at least one UV(C) radiation source 22, exchange period of filter reached, etc.

Fig. 2a shows an housing 2 with a circular cross-section. A front side of said housing 2 has been hinged away to expose the components accommodated in the housing 2. Said front side comprises the air inlet 4 and the air outlet 6. At the inside of the air inlet 4, the dust filter 10 is provided.

The air treatment device 1 further comprises a filter housing 8, comprising a HEPA filter, a first UV radiation source and possibly a cooling unit and/or a carbon filter. In the embodiment illustrated in Fig. 2a, the UV treatment chamber is provided with four first UV radiation sources 22 to provide enough UV radiation per unit time to kill all micro-organisms passing through the UV treatment chamber per unit time. The fan 16 is disposed immediately upstream to the air outlet 6.

Fig. 2b shows a sectional view of the elements present in the air treatment device 1 of Fig. 2a. The arrows in Fig. 2b indicate the direction of airflow through the air treatment device 1.

The air inlet 4 and the air outlet 6 are provided at two ends of the housing 2. A first UV protective cover 30 is provided between the second UV radiation sources (11)and the air inlet 4. Similarly, a second UV radiation protective cover 32 is provided upstream relative to the air outlet 6. Said first and second protective covers 30 and 32 ensure that no UV radiation may pass and leave the air treatment device 1. Air flowing through the treatment device 1 may freely pass through the protective covers 30 and 32.

In Fig. 2c, which is an enlarged part of Fig. 2b, as indicated in Fig. 2b with IIC, the construction of the UV protective cover 30 is illustrated on a larger scale. Using V-shaped plates, preferably coated with a UV radiation absorbing layer, and positioned as shown, prohibits UV radiation passing, but an air flow may freely pass.

Referring to Fig. 2b again, the HEPA filter 12 is cylindrically shaped and coaxially disposed in the housing 2, thus providing a large filter surface. The large filter surface provides a low airflow resistance and good filter characteristics, such as long use life and high filter capacity. The first UV radiation source 11 is disposed in a center of the HEPA filter, as also may be seen in Fig. 2c, radiating its UV radiation on the

surface of the HEPA filter around it. Such a configuration has a further advantage that a direction of the UV radiation is substantially perpendicular to a surface of the HEPA filter. Thus, the UV radiation is more efficiently used, since there are no spots or fibers on the HEPA filter that may be shielded by other fibers.

In the illustrated embodiment, as also may be seen in Fig. 2d (IID in Fig. 2b), also a cooling unit 14A and a carbon filter 14B are provided in the filter housing 8. Further, the four first UV radiation sources 22 disposed in the UV treatment chamber 20 are positioned relative to each other such that in operation the UV radiation intensity inside the UV treatment chamber 20 is substantially homogeneous.

As shown in Fig. 2b and 2e (indicated as IIE in Fig. 2b), downstream to the UV treatment chamber 20, the second UV protective cover 32 is disposed, and further downstream a fan 16 and an ionizer comprising a positive pole 18A and a negative pole 18B are provided.

It is noted that the embodiment of the air treatment device 1 illustrated in Figs. 2a - 2e may comprise a number of sensors, such as one or more temperature sensors, one or more humidity sensors, and/or micro-organism sensors, although they are not shown in Figs. 2a - 2e. Further, the embodiment illustrated in Figs. 2a - 2e functions substantially similar to the embodiment of Fig. 1.

Said micro-organism sensors may determine the number of micro-organisms present in the air. Such a sensor may be provided immediately downstream to the air inlet 4 and immediately upstream to the air outlet 6. Coupling said micro-organism sensors to a processing device enables to determine a sterilization factor or the like. Such a sterilization factor may be displayed. In a more sophisticated embodiment, the number of micro-organisms present in the air may as well be used to control the air treatment device 1.

Since the air treatment device (1) according to the

present invention employs UV radiation of a possibly harmful wavelength, an embodiment may be provided with a number of security measures, such as an opening sensor, which detects opening of an housing and may shut down any UV radiation source to prevent UV radiation radiating on any person.

Further, the UV radiation sources may be of a type that does not generate ozone and the air treatment device may as mentioned above be provided with a display for informing any user of the status of the air treatment device and/or any of the filters. The display may be connected to a processing device that also controls the air treatment device.

As mentioned above, the method and device according to the present invention are suited for killing substantially all micro-organisms present in airflow having a high airflow rate, whereas prior art air treatment devices only filter relatively large micro-organisms and dust particles from an air flow. Figure 3 shows a graph illustrating the pollutants (including particles and micro-organisms) removal rate as a function of the size of the particles and micro-organisms. These pollutants are classified into a number of groups depending on their size: dust, pollen, tobacco (smoke), molds, bacteria and viruses. The solid line represents the performance of a prior art air treatment device and the dashed line represents the performance of the air treatment device according to the present invention.

The prior art device removes up to 100% of all pollutants having a size of up to 1 µm. Some smaller pollutants are removed, but pollutants smaller than about 0.1 µm remain in the air. Thus, up to about 99.97% of the pollutants may be removed from the air. Since sterilization is defined as removing at least 99.9999% of the pollutants, the prior art air treatment device may be indicated to be an air purifier.

The air treatment device according to the present invention also removes smaller air pollutants from the

air. As shown by the dashed line, up to 100% of all pollutants are removed. Tests of independent laboratories (Microsearch Laboratories Ltd. (United Kingdom) and Biotec (Germany)) have shown that more than 99.9999% of the pollutants are removed by the air treatment device according to the present invention. Thus, according to the above-mentioned definition of sterilization, the air treatment device according to the present invention may be indicated to be an air sterilizer.

To prevent that mutated organisms may leave the air treatment device, all micro-organisms need to be killed. Therefore, each micro-organism being exposed to UV radiation must receive a minimum dose of UV radiation that kills said micro-organism. A number of measures may be taken to increase the efficiency of the first UV radiation source and the UV radiation output by said first UV radiation source. For example, the UV treatment chamber may be provided with a reflective layer, the air may be prefiltered, the air may be dehydrated, and the air temperature and airflow rate may be controlled.

Figure 4 illustrates the output efficiency of a UV radiation source as a function of an airflow rate of an airflow passing the UV radiation source, the air having a temperature of about 20°C. The UV radiation output of the UV radiation source is dependent on the operating temperature. The optimum operating temperature of the UV radiation source is 40°C as mentioned above. Due to the passing air, the UV radiation source is cooled. If the airflow cools the UV radiation source, the power consumption may be increased above a rated power level to increase the heat generation. Thus, the UV radiation source may be controlled so that it is always kept at its optimum operating temperature.

As illustrated in Figure 4, the UV radiation source is efficiently driven in airflow having an airflow rate of about 1.52 m/s (about 300 ft/min), which is higher than the minimum required airflow rate of 1.5 m/s as discussed above. At the same time, the UV radiation

source is driven at a power higher than the rated power, thereby generating heat to substantially compensate the cooling effect of the passing air. It is noted that a suitable cover over the UV radiation source as mentioned above may prevent the UV radiation source from abrupt cooling.

The air treatment method according to the present invention, which is practically embodied in the air treatment device according to the present invention, may as well be employed in other treatment devices. For example, for sterilizing objects, UV(C) treatment may be very suitable. In hospitals, for example, many objects need to be sterilized. Further, instead of air, other fluids may be sterilized, such as gases, e.g. oxygen used in hospitals, and water. Depending on the application, prefiltering may be employed.

With the air treatment device and method according to the present invention, bounded spaces can be safely decontaminated, in particular by killing all viruses, bacteria, fungi and other potentially harmful micro-organisms, and by removing dust and other particles. The design of the air treatment device is based on a UV dose required to kill any micro-organisms. A number of parameters, e.g. the measures of the UV treatment chamber, the airspeed inside the UV treatment chamber and the air outlet speed of the airflow, as described in detail above, are selected such that substantially all micro-organisms in a dynamic airflow are killed, while it is ensured that cleaned air mixes with the air present in a room. This means that air on another side of the room is forced to the inlet of the air treatment device. Thus, it is prevented that a number of micro-organisms may mutate into harmfull micro-organisms.

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Enclosure with letter of December 8, 2005

Sch/svk/Silderhuis-1pct

NEW CLAIMS (AMENDMENTS MARKED)

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1. Air treatment device (1) comprising:

- a housing (2) comprising an air inlet (4) and an air outlet (6);

- a fan (16) for stimulating an airflow through the housing (2) from the air inlet (4) to the air outlet (6);

- a UV treatment chamber (20) downstream relative to said air inlet, the UV treatment chamber (20) comprising at least one first UV radiation source (22) for exposing said airflow to UV radiation for killing micro-organisms present in said airflow; and

- a HEPA ~~t least one~~ filter (~~10,~~ 12) positioned upstream relative to the UV treatment chamber (20) for removing particles and micro-organisms having sizes larger than a predetermined filter pore diameter from said airflow before exposing said airflow to said UV radiation;

characterized by

means for controlling at least one of:

(a) the airflow rate;

~~(b) the hydration level;~~

(b~~c~~) the humidity of the air in the UV treatment chamber (20)

(c~~d~~) the power consumption of the first UV radiation source (22) for protecting said first UV radiation source (22) against overheating or undercooling;

(d~~e~~) the power output of the first UV radiation source (22) for protecting said first UV

radiation source (22) from undercooling or overheating;

(e~~f~~) the temperature of the first UV radiation source (22) for protecting said first UV radiation source (22) against overheating or undercooling;

(f~~g~~) the temperature of the air leaving the UV treatment chamber (20), this temperature being a measure for the amount of UV radiation being radiated on the micro-organisms;

(g~~h~~) the temperature in the UV treatment chamber (20), such that said temperature may be kept at a predetermined temperature level; and

(h~~i~~) the air treatment device (1) in response to the number of micro-organisms determined by a micro-organism sensor;

the controlling of any of (a) - (h) taking place in a way such that the micro-organisms receive at least a certain minimum dosis of UV radiation to ensure that they get killed.

2. Air treatment device (1) according to claim 1, the air treatment device (1) comprising:

- a dust filter (10) upstream relative to the UV treatment chamber (20) for removing large dust particles from said airflow; and

- a HEPA filter (12) downstream relative to said dust filter (10) for removing small dust particles and large micro-organisms from the airflow.

3. Air treatment device (1) according to claim 1, the air treatment device (1) comprising a carbon filter (14) downstream relative to the air inlet (4) for removing dust particles and micro-organisms from said airflow.

4. Air treatment device (1) according to claim

2 or 3, wherein a second UV radiation source (11) is provided for irradiating UV radiation on at least one of said at least one filter (10, 12, 14).

5. Air treatment device (1) according to claim 1, wherein the fan (16) is positioned upstream relative to the UV treatment chamber (20) such that the airflow in the UV treatment chamber (20) is substantially turbulent.

6. Air treatment device (1) according to claim 1, further comprising a cooling unit (14A) downstream relative to said at least one filter (10, 12) for cooling, and/or dehydrating by cooling, the airflow.

7. Air treatment device (1) according to claim 6, wherein a humidity sensor (13) is disposed downstream relative to the cooling unit (14A), and a processing device (15) is provided receiving humidity data from said humidity sensor (13), the processing device (15) controlling the cooling unit (14A) to provide a predetermined humidity in the UV treatment chamber (20).

8. Air treatment device (1) according to claim 7, wherein the humidity sensor (13) is disposed in the UV treatment chamber (20).

9. Air treatment device (1) according to any of claims 6 - 8, wherein a first temperature sensor (17) is disposed downstream relative to the cooling unit (14A), and a processing device (15) is provided receiving first temperature data from said first temperature sensor (17), the processing device (15) controlling the airflow rate by controlling the fan (16) speed, to provide a predetermined temperature of the air leaving the UV treatment chamber (20).

10. Air treatment device (1) according to claim 9, wherein the temperature sensor (17) is disposed

immediately downstream relative to the UV treatment chamber (20).

11. Air treatment device (1) according to any of the preceding claims, comprising an ionizer (18), downstream relative to said at least one filter (10, 12) for providing an electron stream substantially perpendicular to the direction of the airflow.

12. Air treatment device (1) according to any of claims 6 - 10, comprising an ionizer (18), downstream relative to the cooling unit (14A) for providing an electron stream substantially perpendicular to the direction of airflow.

13. Air treatment device (1) according to any of the preceding claims, comprising a carbon filter (14) downstream relative to said at least one filter (10, 12).

14. Air treatment device (1) according to any of claims 6 - 10, comprising a carbon filter (14B) downstream relative to said at least one filter (10, 12), the carbon filter (14B) and the cooling unit (14A) being combined to one unit.

15. Air treatment device (1) according to any of the preceding claims, wherein an inner wall of the UV treatment chamber (20) is provided with a UV radiation reflecting layer.

16. Air treatment device (1) according to claim 15, wherein the reflecting layer consists of aluminium.

17. Air treatment device (1) according to claim 15 or 16, wherein the reflecting layer has a rough surface such that reflected UV radiation is scattered.

18. Air treatment device (1) according to any

of claims 15 - 17, wherein the reflecting layer is formed by sputtered aluminium.

19. Air treatment device (1) according to claim 4, wherein the second UV radiation source (11) is provided with a second temperature sensor (17) and a processing device (15) is provided, said processing device (15) receiving second temperature data from said second temperature sensor (17), and controlling the power output of said second UV radiation source (11) for protecting said second UV radiation source (11) from undercooling or overheating.

20. Air treatment device (1) according to any of the preceding claims, further comprising at least one micro-organism sensor for determining the number of micro-organisms present in the air passing said micro-organism sensor.

21. Air treatment device (1) according to claim 20, wherein said micro-organism sensor is connected to a processing device (15), the processing device (15) controlling the air treatment device (1) in response to the determined number of micro-organisms.

22. Air treatment device (1) according to claim 20 or 21, a first micro-organism sensor being positioned immediately downstream relative to the air inlet (4) and a second micro-organism sensor being provided immediately upstream relative to the air outlet (6), said first and said second micro-organism sensors being connected to a processing device (15), determining the sterilization factor from a determined number of micro-organisms present in the air flowing into the air treatment device and a determined number of micro-organisms present in the air flowing out of the air treatment device.

23. Air treatment device (1) according to any

of the preceding claims, wherein the at least one first and/or second UV radiation source (11, 22) is disposed in a cover that is transmissive for the emitted UV radiation.

24. Air treatment device (1) according to claim 23, wherein the cover is made of PTFE (Teflon®).

25. Air treatment device (1) according to any of the preceding claims, wherein the air inlet (4) and the air outlet (6) in the housing (2) are constructed such that no UV radiation can escape from the housing (2).

26. Air treatment device (1) according to any of the preceding claims, wherein a UV radiation absorbing layer is provided on a wall of the housing (2).

27. Air treatment device (1) according to any of the preceding claims, wherein the UV radiation emitted by said at least one first UV radiation source (22) has a wavelength between 253 nm and 257 nm, in particular 253.7 nm.

28. Air treatment device (1) according to claim 4, wherein the UV radiation emitted by the second UV radiation source (11) has a wavelength between 253 nm and 257 nm, in particular 253.7 nm.

29. Air treatment device (1) according to any of the preceding claims, wherein the radiation emitted by said at least one first UV radiation source (22) is UV(C) radiation.

30. Air treatment device (1) according to claim 4, wherein the radiation emitted by said second UV radiation source (11) is UV(C) radiation.

31. Air conditioning system comprising an air treatment device (1) according to claim 1, said ~~the~~ air treatment device (1) comprising:

~~- a housing (2) comprising an air inlet (4) and an air outlet (6);~~

~~- a fan (16) for stimulating an airflow through the housing (2) from the air inlet (4) to the air outlet (6);~~

- a dust filter (10) upstream relative to the UV treatment chamber (20) for removing large dust particles from said airflow; and

~~- a HEPA filter (12) downstream relative to said dust filter (10) for removing small dust particles and large micro organisms from the airflow;~~

- a second ~~-~~UV radiation source (17) for irradiating UV radiation on the HEPA filter (12). ~~; and~~

~~- a UV treatment chamber (20) downstream relative to said HEPA filter (12), the UV treatment chamber (20) comprising a first UV radiation source (22) for irradiating UV radiation in said UV treatment chamber (20).~~

32. Air treatment method comprising the steps of

- generating an airflow;

- filtering by means of a HEPA-filter (12) particles and micro-organisms having sizes larger than a predetermined filter ~~or~~ pore diameter from said airflow before exposing said airflow to ~~said~~ UV radiation;

- exposing said airflow in a UV treatment chamber (20) to UV radiation emitted by a least one first UV radiation source (22)for killing micro-organisms present in said airflow; and

- controlling at least one of:

(a) the airflow rate;

~~(b) the hydration level;~~

(b~~c~~) the humidity in the UV treatment chamber (20)

(c~~d~~) the power consumption of the first UV radiation

source (22) for protecting said first UV radiation source (22) against overheating or undercooling;

(d~~e~~) the power output of the first UV radiation source (22) for protecting said second UV radiation source (22) from undercooling or overheating;

(e~~f~~) the temperature of the first UV radiation source (22) for protecting said first UV radiation source (22) against overheating or undercooling;

(f~~g~~) the temperature of the air leaving the UV treatment chamber (20), this temperature being a measure for the amount of UV radiation being radiated on the micro-organisms;

(g~~h~~) the temperature in the UV treatment chamber chamber (20), such that said temperature may be kept at a predetermined temperature level; and

(h~~i~~) the air treatment method in response to the number of micro-organisms determined by a micro-organism sensor;

the controlling of any of (a) - (h) taking place in a way such that

the micro-organisms receive at least a certain minimum dosis of UV radiation to ensure that they get killed.

33. Air treatment method according to claim 32, comprising the step of:

- dehydrating the airflow before exposing said airflow to said UV radiation.

34. Air treatment method according to any of claims 32 and 33, comprising the steps of:

- determining the temperature of the air in said airflow; and

- controlling the airflow rate in response to said air temperature.

35. Air treatment method according to any of claims 32 – 34, comprising the step of:

- generating an electron stream in said airflow, the electron stream being substantially perpendicular to the direction of said airflow.

36. Air treatment method according to any of claims 32 – 35, comprising the steps of:

- determining the temperature of a UV radiation source (11, 22);

- controlling a power consumption of that UV radiation source (11, 22) for protecting said UV radiation source (11, 22) against overheating or undercooling.

37. Air treatment method according to any of claims 32 – 36, comprising the steps of:

- determining a number of micro-organisms present in said airflow; and

- controlling at least one of (a) the airflow rate, (b) the ~~hydration level~~humidity and (c) a UV radiation source's (11, 22) power consumption in response to the determined number of micro-organisms.

38. Air treatment method according to claim 37, comprising the steps of:

- determining an input number of micro-organisms present in said airflow before exposing said airflow to said UV radiation;

- determining an output number of micro-organisms present in said airflow after exposing said airflow to said UV radiation;

- determining a sterilization factor from said input number of micro-organisms and said output number of micro-organisms; and

- controlling at least one of (a) the airflow rate, (b) the ~~hydration level~~humidity and (c) a

radiation's source power consumption in response to said sterilization factor.

39. Air treatment method according to any of claims 32 - 38, wherein the radiation emitted by said at least one UV radiation source (11, 22) is UV(C) radiation.

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